RF/IF Amplifiers and VGAs Cover The Entire Signal Chain

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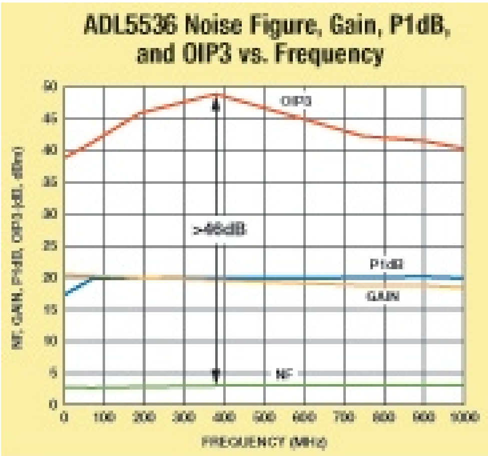
The amplifier is one of the most versatile building blocks used in RF/IF signal chains today. They are commonly used throughout designs to overcome signal losses incurred from passive mixers, filters, baluns, and other passive elements. Since these losses occur across the entire signal chain five main families of amplifiers have been developed by Analog Devices. The five versions are the LNA (low-noise amplifier), IFA (intermediate frequency amplifiers), driver amplifiers, gain blocks, and the VGA (variable gain amplifier).

Though each amplifier family is optimized for certain applications, there are attributes common to all amplifiers that are important to consider during the design phase. Each amplifier will provide some level of gain, but gain variation versus frequency is an important attribute to consider. An amplifiers' gain will typically reduce at higher frequencies, which then may need to be compensated for elsewhere in the signal chain. The amount of information in the data sheet also helps speed along the design process. Data provided such as variation versus temperature, voltage supply, and operating frequency reduces the amount of qualification time a designer needs to spend. That added qualification time can significantly slow down a projects' time-to-market. Another attribute to consider is the amplifiers' ESD rating. The ESD rating relates to the amount of electrostatic discharge a device can withstand without damage. ADI's broadband IFA's and gain blocks are optimized to minimize gain roll-off versus frequency, while all of our amplifiers are fully specified for operation over temperature, supply voltage and operating frequency, thereby easing the selection and design-in process. ADI's amplifiers are also rated to the highest ESD standards, which makes them robust in high volume manufacturing environments.

A common trend in radio designs today is the reduction of both size and power consumption. These efforts help reduce cost by requiring less board space and less heat sinking. ADI's amplifiers are focused on improving efficiency by delivering industry leading performance, on industry leading power consumption. The amplifiers are also offered in the standard SOT-89 package, as well as in smaller and more compact LFCSP packaging, to promote board area savings. ADI also offers integration around our gain block amplifiers with the inclusion of a digital step attenuator, DSA, in the ADL5240 VGA and the inclusion of those two functions with a 0.25 W driver amplifier in the ADL5243 VGA. The entire family of IFA's and gain blocks are 50 O internally matched, and all amplifiers have integrated active bias circuitry, which minimizes the need for external components and further promotes board space savings.

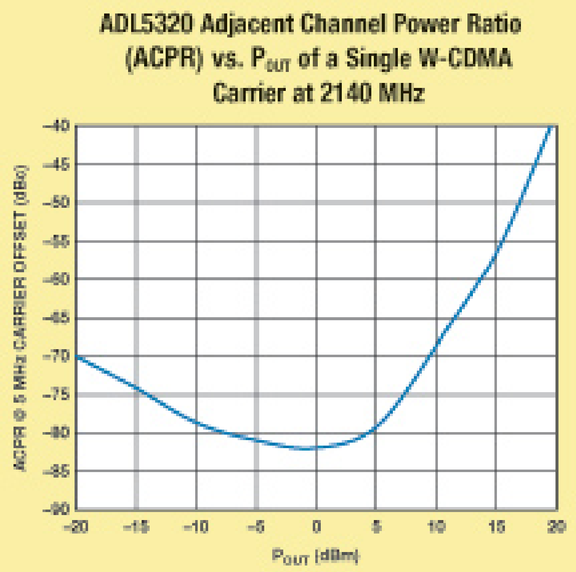
The first amplifier we will discuss in greater detail is the LNA. LNAs are typically used as the first active component in the receive path. They are a critical component for defining overall system performance since they must be able to successfully amplify very low-level signals without adding a significant amount of noise. The important specifications to consider when choosing an LNA are its noise figure, which relates to the amount of noise the amplifier will add to the incoming signal. P1dB and OIP3 are also important specifications, which relates to how much linear signal power the amplifier can output, and its power handling capability which refers to how much input power the amplifier can handle without damage. ADI's ADL5521 and ADL5523 LNAs deliver on all these parameters by accomplishing sub 1 dB noise figures, with 21 dBm P1dB and 37 dBm OIP3, and an input power handling capability of 20 dBm.

Intermediate frequency amplifiers are designed for high performance operation in the IF frequency range, typically below 500 MHz in radio architectures. The IF section of a radio requires high dynamic range amplification, this is necessary so the signal is not distorted prior to digitization by the analog-to-digital converter, ADC. High dynamic range in an amplifier is accomplished by having a low noise figure simultaneously with a high OIP3. ADI's ADL5535 and ADL5536 IFA's provide the industry's best combination of low noise figure and high OIP3. The ADL5536 delivers a 2.7 dB noise figure, with 49 dBm OIP3, at 380 MHz on only 105 mA of 5 V supply current.



ADI's IFA's have high linearity,
low noise figure, flat gain
and low power consumption.

Driver amplifiers are typically used in the transmit path of a radio architecture to increase signal strength prior to the signal being sent to the final high power amplifier stage. To accomplish this effectively the driver needs to offer high linearity for a given output power to enable a low distortion, high-output drive capability. ADI's ADL5320, 0.4 - 2.7 GHz, and ADL5321, 2.3 - 4 GHz, SOT-89 0.25 W drivers provides broadband operation and require minimal external matching for a chosen band of operation. The ADL5320 driver provides an output linearity of 42 dBm and a 25.7 dBm output compression point at 2.14 GHz, while consuming just 104 mA of 5 V supply current.



ADI's driver amplifiers can be driven harder and remain linear, with minimum distortion, while requiring few external components.

The gain block is the most versatile amplifier family as it provides a fixed gain over a wide frequency range from IF up to RF frequencies. The specifications to consider when choosing a gain block really vary according to the application they are going to fill, but gain flatness versus frequency in wideband applications can be important. Dynamic range can also be important in order to not distort signals that are being amplified. ADI's ADL5601 and ADL5602 provide the highest dynamic range available from internally matched gain blocks. This is accomplished by providing extremely low noise figures and very high OIP3 specifications simultaneously, across their entire 4 GHz frequency range. The ADL5602 provides 20 dB of gain, an OIP3 of 42 dBm, and noise figure of 3.3 dB at 2 GHz on just 89 mA of current. These internally matched gain blocks are also optimized to minimize gain roll off versus frequency. Both devices are Class 1C (±1.5 kV) ESD rated and are offered in the industry standard SOT-89 package making it easy to drop-in and evaluate in any current design. The ADL5541 and ADL5542 are broadband gain blocks that operate from low frequencies up to 6 GHz, but are offered in small footprint LFCSP packages.

Integration to reduce board space is desirable in multiple applications. The VGA accomplishes this requirement by integrating various amplifier topologies with a digital-step-attenuator, DSA. Operating in the 100 MHz to 4000 MHz frequency range, the ADL5240 and ADL5243 RF/IF digitally controlled VGAs offer unsurpassed gain control performance and accuracy. Designed with GaAs technology, the ADL5240 VGA combines a DSA and a gain block into a single IC, while the ADL5243 combines a DSA, a gain block, and a broadband 0.25 W driver amplifier in a single IC, without any sacrifice in performance. Either the amplifier or the DSA can be first in the signal chain, maximizing system flexibility by allowing the VGA to be used in multiple places throughout a design. The DSA in each VGA offers a wide gain control range of 31.5 dB in 0.5 dB steps, and accommodates serial and parallel interface modes, while the gain block in each VGA offers a very high linearity of greater than 40 dBm and noise figure of 2.9 at 900 MHz. The ADL5243's 0.25 W driver offers industry-leading linearity performance of 42.0 dBm with an impressive 25.7 dBm P1dB at 2.14 GHz.

Within each RF amplifier family, Analog Devices optimized the performance to cover both broadband and narrowband applications with the minimum number of external passive components, providing considerable savings in board area and design complexity. The entire amplifier family also exhibits high performance levels on low power consumptions, making them well suited for the push toward smaller and lower power consuming systems.

Links:
[1] http://www.analog.com/